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PHEROMONE TRAP CATCH OF THE HARMFUL MICROLEPIDOPTERA SPECIES DEPENDING ON THE OZONE CONTENT OF THE AIR IN HUNGARY

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Abstract

The study deals the efficiency of pheromone trapping of the seven harmful Microlepidoptera species depending on the ozone content of air. Between 2004 and 2011 Csalomon type pheromone traps were operating in Bodrogkisfalud (48°10' N, 21°21' E; Borsod-Abaúj-Zemplén County, Hungary, Europe). We calculated relative catch values from the number of caught insects. We assigned these to the ozone values, we averaged them, and we depicted the results together with the regression equation though.

We established that the pheromone trapping of this species is most fruitful when the ozone content of the air is high. By contrast, low ozone values reduce the successfulness of the catching to a moderate level. Our results will be exploitable in plant protecting and environment conservation research.

KEY WORDS: Microlepidoptera, pheromone trapping, ozone content of air, Hungary.

Introduction

In Hungary, ozone monitoring is carried out at 38 stations of the Hungarian National Meteorological Service. Monitoring at K-puszta has been done since 1990 and in the other cities or villages since 2004.

The instruments used for measurements and description of the methods were described in the previous studies (PUSKÁS & NOWINSZKY, 2010; NOWINSZKY & PUSKÁS, 2011; PUSKÁS & NOWINSZKY, 2011); we refer here only to our former work.

KALABOKAS & BARTZIS (1998), KALABOKAS *et al.* (2000), KALABOKAS (2002), PAPANASTASIOU *et al.* (2002 and 2003), PAPANASTASIOU & MELAS (2006) in Greece have been studying both the monthly changes and those in the different periods of each day of the ozone content. Ozone content in the summer months – from May until August – is higher than in other months of the year. There are typical daily changes. The ozone content is high from noon to evening and goes down from evening to dawn. It hits its lowest point in the dawn hours and begins to rise again in the early morning. Ozone concentrations in the atmosphere depended on several meteorological factors, too (TIWARI *et al.*, 2008). According to JUHÁSZ *et al.* (2006) the ozone content of the atmosphere is still significantly high during the night.

The high concentration of ozone is maleficent to insects. The study of KELLS *et al.* (2001) evaluated the efficacy of ozone as a fumigant to disinfest stored maize. Treatment of 8.9 tonnes of maize with 50 ppm ozone for 3 days resulted in 92–100% mortality of adult Red Flour Beetle, *Tribolium castaneum* (Herbst), adult Maize Weevil, *Sitophilus zeamais* (Motsch.), and larval Indian Meal Moth, *Plodia interpunctella* (Hbn.). Biological effects of ozone have been investigated by QASSEM (2006) as an alternative method for grain disinfestations. Ozone at a concentration of 0.07g/m^3 killed adults of the Grain Weevil (*Sitophilus granarius* L.), Rice Weevil (*Sitophilus oryzae* L.) and Lesser Grain Borer (*Rhyzopertha dominica* Fabr.) after 5-15 hours of exposure. Adult death of the Rice Flour Beetle (*Tribolium confusum* Duv.) and Saw-toothed Grain Beetle (*Oryzaephilus surinamensis* L.) was about 50% after 15-20 hours of exposure. The total adult death of all insect species occurred with 1.45 g/m^3 ozone concentration after one hour of exposure. VALLI & CALLAHAN (1968) examinations made with light traps indicated an inverse relationship between O_3 and insect activity.

Material and Methods

Between 2004 and 2011 Csalomon type pheromone traps were operating in Bodrogkisfalud (48°10' N, 21°21' E; Borsod-Abaúj-Zemplén County, Hungary, Europe). Data on the Hawthorn Red Midget Moth (*Phyllonoricter corylifoliella* Hbn.) were collected between 2008 and 2011 only. These traps attracted 7 Microlepidoptera species. Every year 2-2 traps per species were collected; one night after a 2-2 catching, data were available. The catch data of the collected species is displayed in Tab. I.

Table I. Pheromone trap catch of the examined Microlepidoptera species.

Species	Number of moths	Number of data
Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabricius, 1781)	53515	2092
Red Midget Moth (*Phyllonorycter corylifoliella* Hübner, 1796)	5834	929
Codling Moth (*Cydia pomonella* Linnaeus, 1758)	7002	1771
Peach Twig Borer (*Anarsia lineatella* Zeller, 1839)	5957	1605
European Vine Moth (*Lobesia botrana* Denis et Schiffermüller, 1775)	6993	1738
Oriental Fruit Moth(*Grapholita molesta* Busck, 1916)	11830	1996
Plum Fruit Moth (*Grapholita funebrana* Treitschke, 1846)	23386	2144

The traps near each other worked all year. They were placed on leafy trees of the same branches and vines at a distance of 50 meters between the traps. The height of each species was different, from 1.5 to 2 meters. The traps operated from the beginning of April to the end of September. According to TÓTH (2003) the proposed capsules exchange was in a 6-8 week period. The number of moths captured per day was recorded, which is different from the general practice of counting the catch two or three days together.

The pheromone traps operated in the same orchards and vineyards in every year. There were no performed chemical pest control treatments.

In Hungary, ozone monitoring is carried out at four stations of the Hungarian National Meteorological Service. Monitoring at K-puszta has been done since 1996 and in 37 other cities and villages since 2004. Today 10 minute average concentration values are detected at every station with the help of the ozone monitors. Since 1998, MILOS has forwarded data and QLC that were collected earlier by a local data collecting software (SCANAIR) and stored in PCs. SCANAIR reduced 15-minute data into half-hour averages which were then entered in the data base. At the stations the job is performed by an Environment type monitor. A Thermo Electron type monitor executes parallel monitoring at stations. The ozone monitors are UV photometric ozone analysers which, with a UV lamp, establish ozone concentration by illuminating an air sample drawn into an absorption cell, then measure the decline of illumination at a wavelength of 254 nm. The extent of this is proportional to the ozone content of the air. The instrument establishes the ozone concentration in a ppb unit, by taking samples in every 10 minutes. The data are in a 0-150 ppbs range. Sometimes negative values are received after calibration: this is to be handled as 0. High ozone values (> 100 ppb) occur mainly in the summer season, sometimes in early spring. Values over 120 ppb were measured vary rarely (so far in 1-2 cases). A Thermo Electron type ozone calibrator is being used. Every measuring instrument must be calibrated at least once a year. In fact, the ozone calibrator must be regularly adjusted to the international standard (in Prague), too. Calibration and data control cannot be fully automated, as the daily curves must be checked separately and outliers must not be automatically discarded. Each item of data is marked with an error code, which characterizes the quality of the data. Every external circumstance, including the various meteorological features (wind direction, wind speed, temperature, etc.), must be examined in order to explain extreme and clearly incorrect ozone values. A final file of data stores the raw measurement data, the calibrated and controlled data and the mistake code referring to data quality. The database is copied to CDs annually (PUSKÁS *et al.*, 2001).

Ozone content in the summer months – from May until August – is higher than in other months of the year. There are typical daily fluctuations. The ozone content is high from noon to evening and decreases from evening to dawn. It hits its lowest point in the dawn hours and begins to rise again in the early morning.

From the catching data of the examined species, relative catch (RC) data were calculated for each observation posts and days. The RC is the quotient of the number of individuals caught during a sampling time unit (1 night} per the average number of individuals of the same generation falling to the same time unit. In the case of the expected averaged individual number, the RC value is 1. The introduction of RC enables us to carry out a joint evaluation of materials collected in different years and at different traps.

The ozone content values and the moths caught were calculated with consideration to the method of Sturges (ODOR & IGLÓI, 1987). The RC values of a species from all sites and years were arranged into the proper classes. The results obtained are plotted. We determined the regression equations, the significance levels which were shown in the figures.

Results and Discussion

Our results, including regression equations and significance levels, are displayed in Figs.1-7. Our results have shown that high ozone content of the air is accompanied by a higher pheromone trap catch. Our previous work has demonstrated that when the atmospheric ozone content is high, the flying activity of the several insect species increases and their light-trap catch will be more effective.

The relationship of pheromone trap relative catch to ozone concentration can be described using different types of functions. For the following species: *Phyllonoricter blancardella* Fabr., *Cydia pomonella* L., *Lobesia botrana* Den. et Schiff. and *Grapholita funebrana* Treitschke, such ratio can be described by logarithmic function. On the other side, for species such: *Phyllonoricter corylifoliella* Haw., *Anarsia lineatella* Zeller and *Grapholita molesta* Busck, named relation can be described using second or third degree polynomial functions.

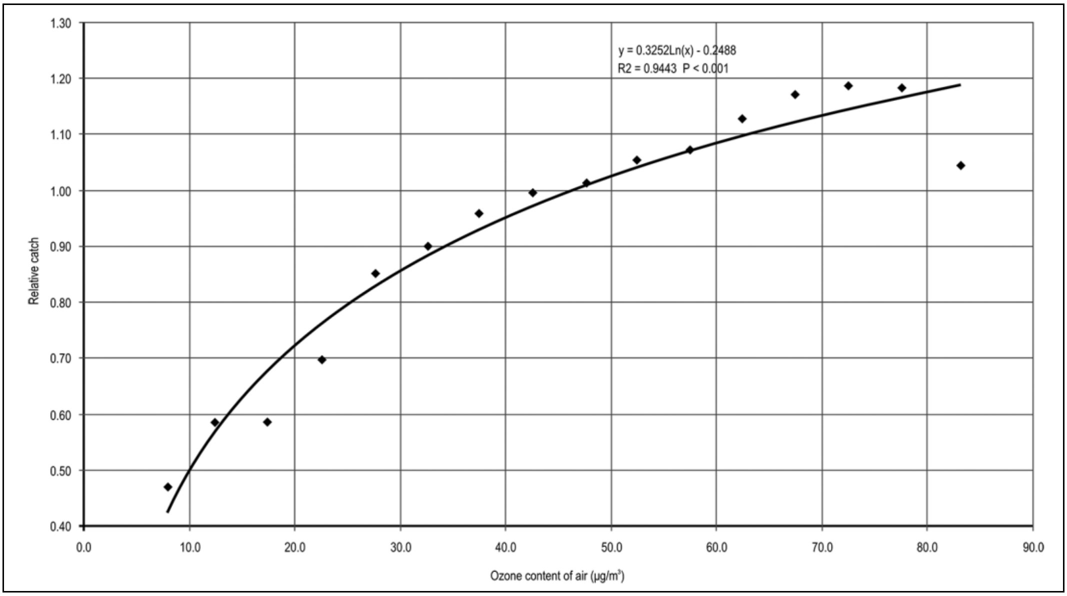

Figure 1. Pheromone trap catch of the Spotted Tentiform Leafminer (*Phyllonorycter blancardella* Fabr.) depending on the ozone content of air.

These facts are certified for the Scarce Bordered Straw (*Helicoverpa armigera* Hbn.) by PUSKÁS & NOWINSZKY (2010), for the European Corn Borer (*Ostrinia nubilalis* Hbn.) and the Common Cockchafer (*Melolontha melolontha* L.) by NOWINSZKY & PUSKÁS (2011), PUSKÁS & NOWINSZKY (2011) and for the *Ecnomus tenellus* Rambur (a Trichoptera species) by PUSKÁS *et al*. (2011). Our current work can be done based on a similar statement of pheromone trap catch in the harmful moth species also.

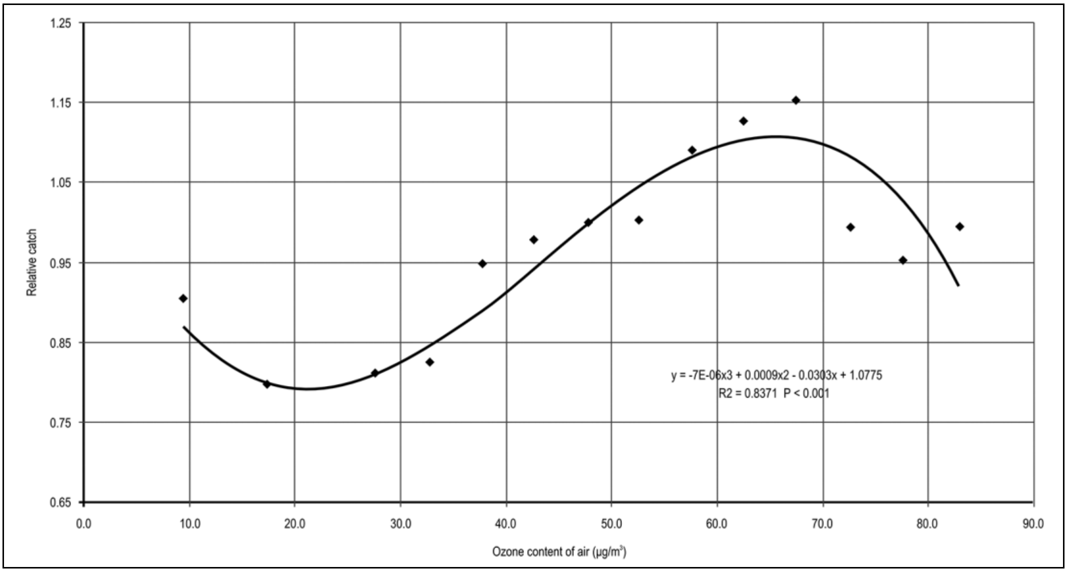

Figure 2. Pheromone trap catch of the Hawthorn Red Midged Moth (*Phyllonorycter corylifoliella* Hbn.) depending on the ozone content of air.

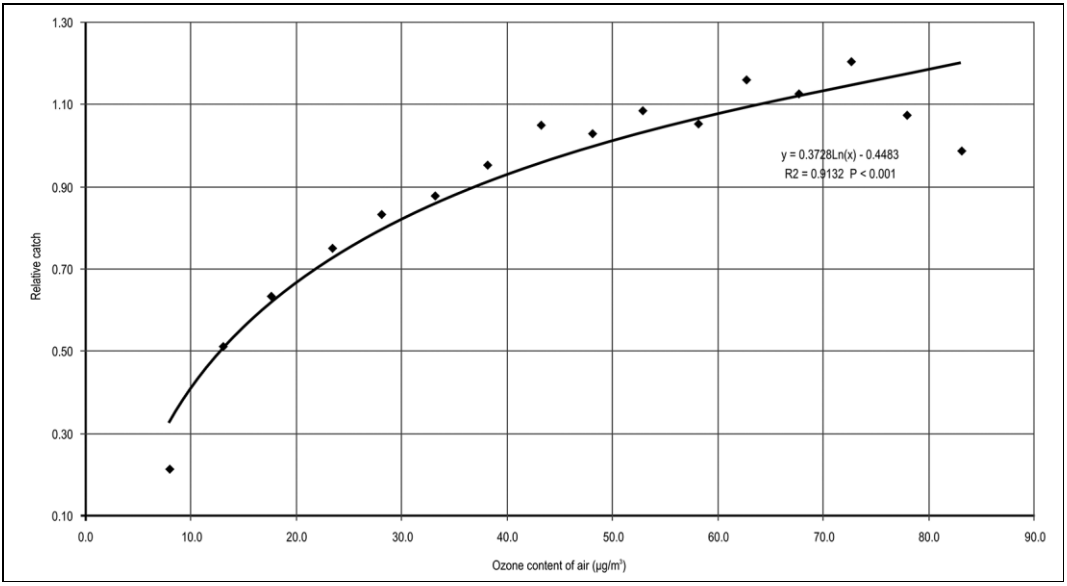

Figure 3. Pheromone trap catch of the Codling Moth (*Cydia pomonella* L.) depending on the ozone content of air.

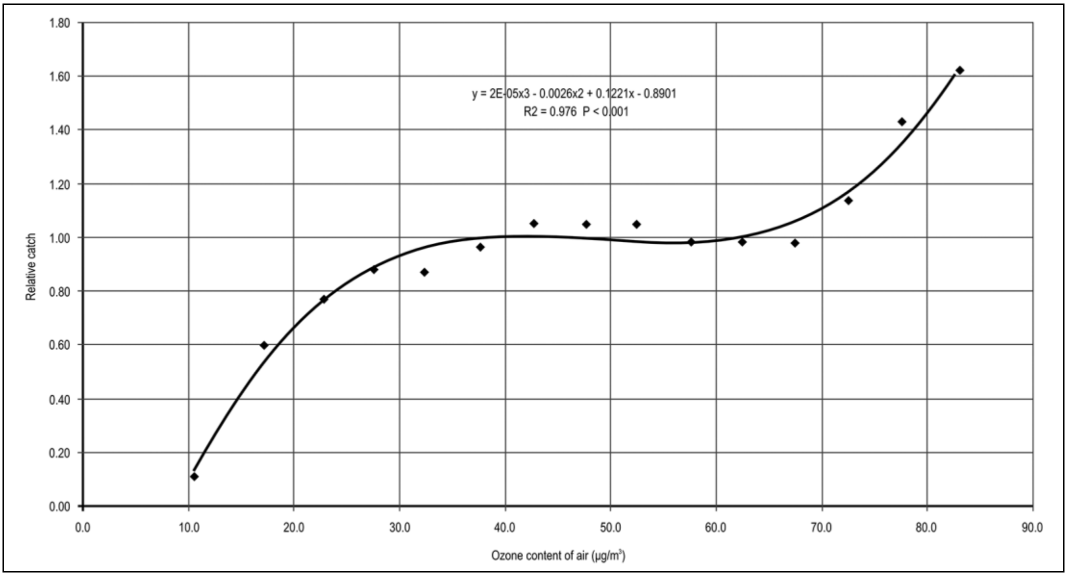

Figure 4. Pheromone trap catch of the Peach Twig Borer (*Anarsia lineatella* Zeller) depending on the ozone content of air.

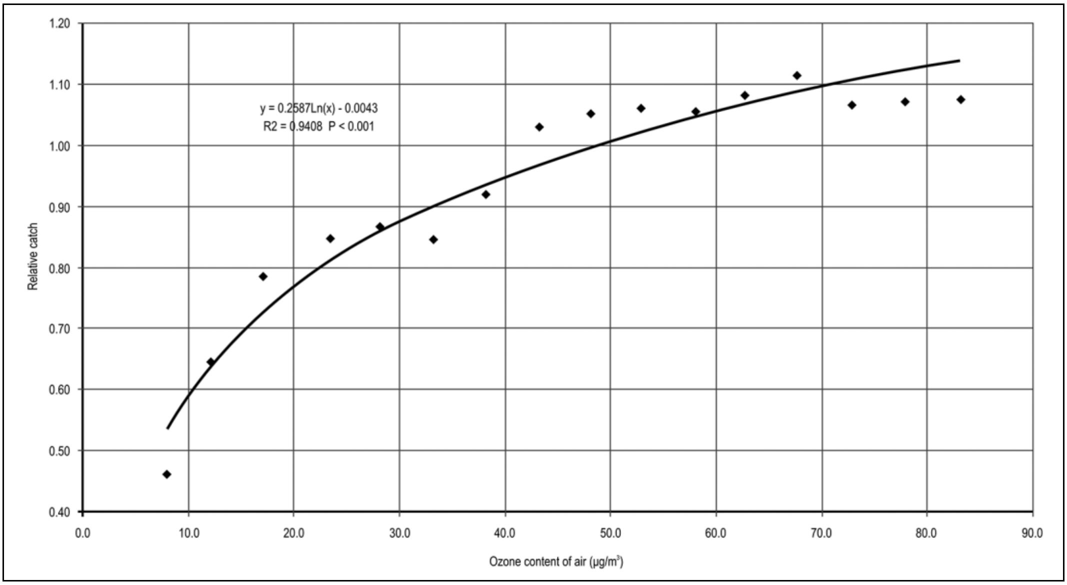

Figure 5. Pheromone trap catch of the European Vine Moth (*Lobesia botrana* Den. et Schiff.) depending on the ozone content of air.

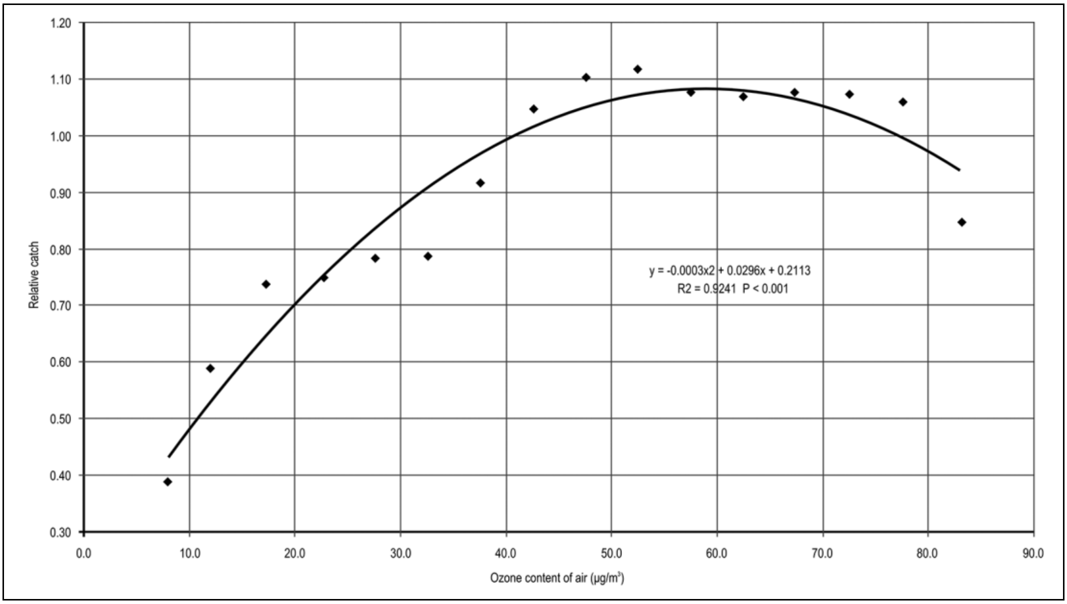

Figure 6. Pheromone trap catch of the Oriental Fruit Moth (*Grapholita molesta* Busck) depending on the ozone content of air.

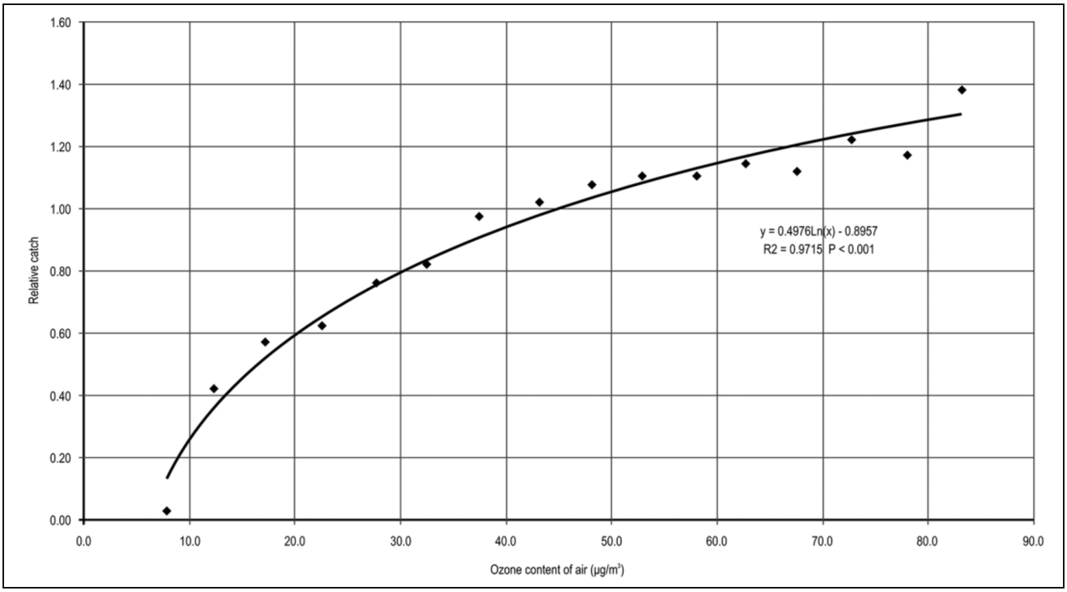

Figure 7. Pheromone trap catch of the Plum Fruit Moth (*Grapholita funebranaa* Tr.) depending on the ozone content of air.

We found that the pheromone trap catch of five harmful moth species increases in strength when the atmospheric ozone content is more than 40 μg/m^3 and in the case of two species when it is more than 50 μg/m^3. In contrast, the low ozone content of air significantly reduces the pheromone trap catch success of these examined species.

Higher concentrations of ozone are generally typical on those days when a stronger UV radiation can be measured. Probably the daily average temperature and temperature of swarming hours are higher on these days because of the more intensive sunshine. This can cause intensive flight activity and also high value in catch. Some literature, however, suggests that direct ozone effect on behaviour cannot be ruled out.

The pheromone trap catch of the death-borer beetles seems to support the theory that the flight activity of some insects is increased as a direct consequence of increased ozone concentration (GRODZKI *et al*., 2004). However, due to expected increased tropospheric ozone concentration in future, to clarify the direct or indirect influence of ozone concentration on the flight activity of the insects, further investigation will be required.

We suggest similar examinations of other harmful insect species be done with other relevant sampling methods (for example light-, suction-, Malaise-, bait traps). If it were proved that the high ozone content of air increases the flying activity of other insect species, it will be necessary to take this fact into consideration when developing the plant protection prognoses. Moreover, more accurate plant protection prognosis could be prepared. Our result contradicts that of VALLI & CALLAHAN (1968), who experienced a decrease in the activity of Corn Earworm (*Heliothis zea* Boddie) with the parallel increase of the ozone content. This contradiction may be due to the fact that low relative catch values always refer to environmental factors in which the flight activity of insects diminishes. However, high values are not so clear to interpret. Major environmental changes bring about physiological transformation in the insect organism. The imago is short-lived; therefore an unfavourable environment endangers the survival of not just the individual, but the species as a whole. In our hypothesis, the individual may adopt two kinds of strategies to evade the hindrances to the normal functioning of its life phenomena. It may either display more liveliness, by increasing the intensity of its flight, copulation and egg-laying activity, or it may take refuge in passivity to environmental factors which create an unfavourable situation. And so, given the present state of our knowledge, we might say that both favourable and unfavourable environmental factors might be accompanied by an equally high catch (NOWINSZKY, 2003).

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УЛОВ ШТЕТНИХ ВРСТА МИКРОЛЕПИДОПТЕРА ФЕРОМОНСКИМ КЛОПКАМА У ЗАВИСНОСТИ ОД САДРЖАЈА ОЗОНА У ВАЗДУХУ

ЛАСЛО НОВИНСКИ, ГАБОР БАРЦИКАИ и ЈАНОШ ПУШКАШ

Извод

У раду је истраживана ефикасност феромонских клопки код седам врста Microlepidoptera у зависности од садржаја озона у ваздуху. У периоду од 2004. до 2011. постављане су феромонске клопке "Csalomon" у месту Бодрогкишфалуд (Bodrogkisfalud) у Мађарској. Израчунате су релативне вредности улова према броју ухваћених примерака. Наши резултати су показали да је висок садржај озона у ваздуху пропраћен великим уловом инсеката у феромонским клопкама. Насупрот томе, ниске вреднсоти озона смањују успешност улова на осредњи ниво. Добијени резултати биће искоришћени у заштити биља и очувању животне средине.

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